CLAIMS 53621

Claims 1-28 (canceled)

29. (new) A process for preparing optionally alkyl-substituted 1,4-butanediol by two-stage catalytic hydrogenation in the gas phase of C_4-dicarboxylic acids and/or of derivatives thereof having the following steps:

a) introducing a gas stream of a C_4-dicarboxylic acid or of a derivative thereof at from 200 to 300°C and from 2 to 60 bar into a first reactor and catalytically hydrogenating it to a product which contains mainly optionally alkyl-substituted γ-butyrolactone;

b) converting the product stream into the liquid phase;

c) introducing the product stream obtained in this way into a second reactor at a temperature of from 100°C to 240°C and a pressure of from 20 to 250 bar and catalytically hydrogenating it in the liquid phase to optionally alkyl-substituted 1,4-butanediol;

d) removing the desired product from by-products and any unconverted reactant;

e) optionally recycling intermediates into one or both hydrogenation stages, said hydrogenation stages both using a catalyst which comprises ≤95% by weight of CuO, and ≥ 5% by weight of a support, said second reactor having a higher pressure than said first reactor, and the product mixture removed from said first reactor being introduced without further purification into said second reactor.

30. (new) A process as claimed in claim 29, wherein the entrance temperature into the first reactor is from 235 to 270°C and the entrance temperature into the second reactor is from 120°C to 200°C.

31. (new) A process as claimed in claim 29, wherein the hot spot temperature in the first reactor is from 210 to 310°C and the process is carried out in such a manner that the hot spot temperature is above the entrance temperature and the exit temperature of the reaction gases, and is from 5 to 30°C above the entrance temperature.

32. (new)A process as claimed in claim 29, wherein the pressure in the first hydrogenation stage is from 2 to 20 bar and the pressure in the second hydrogenation stage is from 60 to 200 bar.

33. (new) A process as claimed in claim 29, wherein the catalyst hourly space velocity of the first hydrogenation stage is in the range from 0.02 to 1 kg of reactant/1 catalyst · hour, and the catalyst hourly space velocity of the second hydrogenation stage is in the range from 0.02 to 1.5 kg of the reactant/1 of catalyst · hour.

34. (new) A process as claimed in claim 29, wherein the hydrogen/reactant molar ratio in both reaction stages is > 5.

35. (new) A process as claimed in claim 34, wherein the hydrogen/reactant ratio in the first stage hydrogenation is from 20 to 200.

36. (new) A process as claimed in claim 29, wherein the reactors used in the first and second hydrogenation stages are selected from the group consisting of

tubular reactors, shaft reactors, reactors having internal heat removal means, tube bundle reactors and fluidized bed reactors.

37. (new) A process as claimed in claim 36, wherein a tube bundle reactor is used in the first hydrogenation stage.

38. (new) A process as claimed in claim 36, wherein a loop or shaft reactor is used in the second hydrogenation stage.

39. (new) A process as claimed in claim 29, wherein the hydrogenation in the second stage is carried out as a suspension hydrogenation or fixed-bed hydrogenation, in particular as a fixed-bed hydrogenation.

40. (new) A process as claimed in claim 29, wherein more than one reactor connected in parallel or in series is used in the first and/or second hydrogenation stage.

41. (new) A process as claimed in claim 29, wherein the support material of the catalyst is selected from the group of ZnO, Al_2O_3, SiO_2, TiO_2, ZrO_2, CeO_2, MgO, CaO, SrO, carbon of varying origin, BaO and Mn_2O_3 and mixtures thereof.

42. (new) A process according to claim 41, wherein the support material is selected from the group of ZnO/Al_2O_3 mixtures, the delta-, theta-, alpha- and eta-modification of Al_2O_3 and also mixtures which comprise at least one component each firstly from the group of SiO_2, TiO_2, ZrO_2, and secondly from the group of ZnO, MgO, CaO, SrO and BaO.

43. (new) A process as claimed in claim 29, wherein the support material is selected from ZnO, ZnO/Al_2O_3 mixtures in a weight ratio of from 100:1 to 1:2 and mixtures

of SiO2 with MgO, CaO and/or ZnO in a weight ratio of 200:1 to 1:1.

44. (new) A process as claimed in claim 29, wherein the catalyst comprises one or more further metals or a compound of one or more further metals, preferably an oxide, from groups 1 to 14 of the Periodic Table.

45. (new) A process according to claim 44, wherein the further metal is Pd.

46. (new) A process as claimed in claim 29, wherein the catalyst is used in the form of shaped bodies.

47. (new) A process according to claim 46, wherein the catalyst is used in the form of extrudates, ribbed extrudates, tablets, rings, spheres or spall.

48. (new) A process as claimed in claim 29, wherein the BET surface area of the copper catalysts in the oxidic state is from 10 to 1 500 m^2/g.

49. (new) A process as claimed in claim 29, wherein the copper surface area of the reduced catalyst in the installed state is > 0.2 m^2/g.

50. (new) A process as claimed in claim 29, wherein the catalyst used in the first and second reactors different.

51. (new) A process as claimed in claim 29, wherein the shaped bodies of the catalyst used have a pore volume of > 0.01 ml/g for pore diameters of > 50 nm.

52. (new) A process as claimed in claim 29, wherein the ratio of micropores having a diameter of > 50 nm to the total pore volume for pores having a diameter of > 4 nm is > 10%.

53. (new) A process as claimed in claim 29, wherein the reactant used in the reaction is maleic anhydride.

54. (new) A process as claimed in claim 29, wherein maleic anhydride is used which has been prepared by oxidizing benzene, C_4-olefins or n-butane, and the crude maleic anhydride obtained by oxidation has been extracted from the crude product mixture using a solvent and then stripped from this solvent using hydrogen.

55. (new) A process as claimed in claim 29, wherein the absorbent is selected from the group consisting of tricresyl phosphate, dibutyl maleate, high molecular weight waxes, aromatic hydrocarbons having a molecular weight of from 150 to 400 and a boiling point above 140°C, di-C_1-C_4-alkyl esters of aromatic and aliphatic dicarboxylic acids, methyl esters of long-chain fatty acids having from 14 to 30 carbon atoms high-boiling ethers, and alkyl phthalates and dialkyl phthalates having C_1-C_{18}-alkyl groups.

56. (new) A process as claimed in claim 29, wherein the maleic anhydride is stripped from the absorbent under reduced pressure or pressures which correspond to the hydrogenation pressure or are a maximum of 10% above this pressure.

57. (new) A process as claimed in claim 29, which is carried out batchwise, semicontinuously or continuously.

58. (new) A process as claimed in claim 29, wherein hydrogen is removed from the liquid stream of the first hydrogenation before it is introduced into the second hydrogenation.

59. (new) A process as claimed in claim 29, wherein the water of reaction formed is substantially removed from the condensed product stream before it enters the

second hydrogenation reactor.